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Effect of seed size and plant spacing on the economics of various treatments of cv. Kufri Khyati

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Abstract
An experiment was conducted to study the effect of seed size and plant spacing on seed potato production cv. Kufri Khyati" at Vegetable Seed Production and Research Farm, KVK Sonipat during winter of 2017-18. Fifteen treatment combinations of five different tuber size planted at three different plant spacing were analyzed for twelve growth and yield parameters. Result of this experiment revealed that among different treatment combinations, seed size of 91-120 g at 60x20 cm spacing produced significantly maximum total tuber yield (358.60 q) per hectare over small and large seed size tubers which was found at par with the seed size 61-90 g (338.61q) at spacing 60x20 cm, while the maximum net return (Rs. 102431/ha) was found highest when 61-90 g seed was planted at spacing 60x20 cm.

Keywords: Seed size, plant spacing, economics, various treatments

Introduction
Potato (*Solanum tuberosum* L.), also called as white or Irish potato belongs to Solanaceae family, is an annual herbaceous plant. Potato is used as a principal vegetable in most of the tropical countries. As a crop, it possesses the highest production potential per unit area and time. Potato is the third most consumed crop globally after rice and wheat. Potato originated from the high Andes of central and southern America. China is now the largest potato producer, and almost one third of all potatoes of world are harvested in China and India. Potato acquires fourth position in major food crops of the world after rice, wheat and maize. It is highly nutritious, easily digestible and wholesome food, containing 80% water and 20% dry matter consisting of 14% starch, 2% protein, 2% sugar, 1% minerals, 0.6% fibre, 0.1% fat and trace amount of vitamin B and C. It is utilized as vegetable, stock feed and also in industries for the manufacturing of starch and alcoholic beverages and processed into different commercially used dehydrated, canned and fried products like chips and sliced potato (Hazra *et al*., 2015) [2]. It has been often addressed as a future food crop by Food and Agriculture Organization due to its tremendous potential of producing highest food, energy and protein per unit area and time. Potato yields about 97 cal/100 g fresh weight, which is much higher than cereal crops.

The yield of potato depends on many factors. It is therefore becomes essential to understand how individual plant interacts with environment and possibly to come up with the ideal crop density levels to optimize yield. It becomes imperative that optimum seed size and spacing levels need to be established

to ensure optimum yield performance and better monetary returns to farmers (Kabir *et al*., 2004) [3] in a given geographic area. Seed spacing has been reported to influence yield, tuber size distribution, stem density and net return of potato cultivars (Vander *et al*., 1990; Love and Thompson, 1999; Zamil *et al*., 2010) [8, 6, 9]. Despite many investigations carried out over many years on this important crop, more information is required on interrelationships of plant population and tuber sizes with respect to its growth and subsequent yield. Some important studies were done past few decades, while others are recent (Das and Deka, 2002; Khan *et al*., 2010) [1, 4].

The present study was, therefore, undertaken to study the effect of seed size and plant spacing on seed potato production cv. Kufri Khyati.

Materials and Methods
The experiment was carried out at Vegetable Seed Production and Research Farm, KVK Sonipat during winter of 2017-18, located at latitude of 28º 59' North, longitude of 70º 00' East

and at an altitude of 249 meter above mean sea level. The experimental material comprised of five different size of tubers *i.e.*, 15-30 g, 31-60 g, 61-90 g, 91-120 g & 121-150 g planted at three different plant spacing of 60 x 20 cm, 60 x 30 cm & 60 x 40 cm. A total of 15 treatment combinations with three replications were planted in Randomized Block Design having plot size of 4.8 m x 3.6 m. During the course of experimentation, various observations were recorded for growth and yield parameters *i.e.*, Plant emergence (%) at 15 and 30 DAP, Plant height (cm) at 45, 60, 75 and 90 DAP, Number of stems per hill at 45 DAP, Number of leaves per hill at 50 DAP, Leaf weight per hill at harvest, Stem weight per hill at harvest, Weight of tubers in different grades (0-25, >25-50, >50-75, >75g), Number of tuber in different grades (0-25, >25-50, >50-75, >75g), Total tuber yield (q/ha), Harvest index (%), Tuber dry matter content (%), Percent seed tuber and also the economics of various treatments was calculated. All the recommended cultural practices were adopted for raising the crop successfully. The crop was dehaulmed after 100 days of planting. All plots were harvested after ten days of de-haulming to allow tuber hardening (curing). Various treatment combinations were then analyzed to find out the best combination for seed potato production.

Results and Discussion

Total Tuber Yield

As shown in table no. 1, the total tuber yield was found significantly highest (287.93 q) for the seed size 91-120 g, which was followed by the treatments having seed sizes 121-150 g (270.57 q). The significantly lowest yield (169.12 q) was registered with the treatment where seed size 15-30 g was used. Among the plant spacing, the highest tuber yield was observed at the spacing of 60x20 cm (295.80 q) which was followed by plant spacing of 60x30 cm (235.90 q). The lowest tuber yield (183.32 q) was observed with the treatment where the spacing was 60x40 cm. Among different treatment combinations, seed size of 91-120 g at 60x20 cm spacing produced significantly maximum total tuber yield (358.60 q) per hectare over small and large seed size tubers which was found at par with the seed size 61-90 g (338.61q) at spacing 60x20 cm. The lowest tuber yield (132.51 q) was recorded with the treatment where seed size 15-30 g was used with 60x40 cm spacing. Total yield of tuber increased significantly with increase in seed size except 121-150 g. Malik *et al*. (2002) [7] also reported that the yield per plant and tuber yield per hectare were recorded higher with larger seed size tubers as compare to smaller seed size tubers. The significant increase in tuber yield per hectare under larger seed size tubers was due to their favorable effect on tuber yield per plant. The better growth in terms of stem per hill appeared to have been due to more photosynthesis and eyes presents in the larger size tubers, which resulted in higher yield per plant and finally accompanied by a corresponding increase in tuber yield per hectare. Lal *et al.* (1981) [5] reported that the increase in stem per hill has also been reported as an attributed to higher tuber yield per plant.

Table 1: Effect of seed size and plantspacingon total tuber yield (q/ha) of potato variety Kufri Khyati

Seed size (g)	Plant spacing(cm)			
	60x20	**60x30**	**60x40**	**Mean**
15-30	206.24	168.62	132.51	169.12
31-60	242.79	189.41	154.30	195.50
61-90	338.61	270.54	196.61	268.59
91-120	358.60	287.70	217.47	287.93
121-150	332.77	263.22	215.71	270.57
Mean	295.80	235.90	183.32	
C.D at 5% level	Seed size: 13.06	Plant spacing: 10.12	Seed size x Plant spacing: 22.62	

Economics of various treatments

The data on economics of various treatments of seed size and plant spacing are presented in Table 2. Among different treatments, the highest net return (Rs. 102431/ha) was obtained in treatment, 61-90 g seed size with plant spacing 60x20 cm, which was followed by treatment, 91-120 g seed size with plant spacing 60x20 cm (Rs. 93,153/ha). Though the treatment combinations having seed size of 91-120 g planted at 60x20 cm spacing produced significantly maximum total tuber yield (358.60 q) per hectare but also incurred higher cost of cultivation as comparison to seed size 61-90 g planted at spacing 60x20 cm which produced 338.61q of tuber yield. The lowest net return was noted in treatment 31-60 g seed size with plant spacing 60x40 cm (Rs. 31,549/ha). In terms of benefit to cost ratio, the treatment, 61-90 g seed size with plant spacing 60x30 cm gave the highest benefit to cost ratio (1.33) followed by the treatment, 61-90 g seed size with plant spacing 60x20 cm (1.26). The lowest benefit to cost ratio (0.46) was recorded in treatment, 121-150 g seed size with plant spacing 60x20 cm.

Table 2: Economics and net returns of different treatments in Potato cv. Kufri Khyati

Treatments	Yield (t/ha)	Cost of cultivation (Rs/ha)			Cost (Rs/ha)		Sale prices (Rs/q)	B:C ratio
		Seed	Fertilizer	Cultivation	Inputs	Produce	Net returns (Rs/ha)	
Spacing 60 x 20 cm								
S1 (15-30 g)	18.17	21250	6627	24500	52377	109044	56667	1.08
S2 (31-60 g)	21.27	45000	6627	24500	76127	127620	51493	0.68
S3 (61-90 g)	30.59	50000	6627	24500	81127	183558	102431	1.26
S4 (91-120 g)	32.38	70000	6627	24500	101127	194280	93153	0.92
S5 (121-150 g)	29.47	90000	6627	24500	121127	176790	55663	0.46
Spacing 60 x 30 cm								
S1 (15-30 g)	15.35	14167	6627	24500	45294	92100	46806	1.03
S2 (31-60 g)	17.08	30000	6627	24500	61127	102480	41353	0.68
S3 (61-90 g)	25.07	33333	6627	24500	64460	150414	85954	1.33
S4 (91-120 g)	26.71	46667	6627	24500	77794	160236	82442	1.06
S5 (121-150 g)	24.05	60000	6627	24500	91127	144282	53155	0.58
Spacing 60 x 40 cm								
S1 (15-30 g)	12.24	10625	6627	24500	41752	73434	31682	0.76
S2 (31-60 g)	14.20	22500	6627	24500	53627	85176	31549	0.59
S3 (61-90 g)	18.25	25000	6627	24500	56127	109476	53349	0.95
S4 (91-120 g)	19.83	35000	6627	24500	66127	118974	52847	0.80
S5 (121-150 g)	19.69	45000	6627	24500	76127	118110	41983	0.55

Conclusion

Based on the finding of one season study conducted during *rabi* season, it may be concluded that among different treatments, seed size of 91-120 g planted at 60x20 cm spacing produced significantly maximum total yield per hectare (358.60 q) which was found at par with the seed size 61-90 g at spacing 60x20 cm (338.61 q), while the highest net return (Rs. 102431/ha) was obtained in treatment, 61-90 g seed size with plant spacing 60x20 cm as shown in table no. 2. Hence based on the current study treatment combination of 61-90 g seed size with plant spacing 60x20 cm was found best for economic point of view.

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